Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

PUBLIC HEALTH REPORTS

VOL. XXVII. NOVEMBER 22, 1912. No. 47.

SEPTIC SORE THROAT.

A MILK-BORNE OUTBREAK IN BALTIMORE, MD

EPIDEMIOLOGICAL STUDY OF THE OUTBREAK.

By WADE H. FROST, Passed Assistant Surgeon, United States Public Health Service.

Early in March, 1912, many of the physicians in Baltimore became impressed with the fact that they were encountering, in their practice, an altogether unusual number of cases of sore throat which differed in some striking particulars from cases ordinarily observed.

The distinctive clinical features of these cases as described by Dr. Louis P. Hamburger [1] in a recent publication and probably observed by numerous other physicians in Baltimore were sudden onset with a chill; irregular fever, sometimes surprisingly high; diffuse inflammation of the tonsils and fauces; enlargement of the cervical glands; unusual prostration; and a characteristically prolonged remittent course.

While sore throat was the most prominent of the early symptoms, the severity of the inflammation in the throat varied greatly. In some cases there was seen only a diffuse redness and brawny edema of the tonsils and peritonsillar tissue; in others there was a foul, pseudo-diphtheric exudate covering the tonsils and fauces.

The frequent marked and persistent enlargement of the cervical glands was one of the most striking features of these cases. The enlargement often continued many weeks, but only rarely did the glands suppurate.

Otitis media is said to have been, next to adenitis, the most common complication. Not infrequently more severe complications developed, such as general septicemia, septic arthritis, or erysipelas, causing death within a few days. It was commonly noted that in the cases with severe septicemic complications the glandular enlargement was slight or absent.

Cultures from the throats of patients, from their middle ear discharges, and from the peritoneal exudate of cases complicated with peritonitis showed quite uniformly the presence of a diplo-streptococcus which, in smears, bore a close resemblance to the pneumococcus.

---

[1] Hamburger, Louis P.: An epidemic of septic sore throat in Baltimore and its relation to a milk supply. Jour. Am. Med. Assn., Apr. 13, 1912, vol. 58, p. 1109.

Realizing the gravity of the epidemic which confronted them, a number of physicians held an informal meeting about the middle of March to discuss and compare their cases and to consider the possible sources of the epidemic. The similarity of this outbreak to one occurring in Boston in May, 1911, and shown by Winslow[1] to have been due to infection of a large dairy, suggested at once the possibility of the Baltimore epidemic being likewise milk-borne.

This suspicion was strikingly confirmed by the reports of the physicians in attendance at the meeting. Almost without exception those who knew the milk supply of their patients reported that it came from one of the largest and best dairies in the city, which in this report will be referred to as "Dairy No. 1." Several of those who had not ascertained the source of their patients' milk supply telephoned to their families from the meeting, receiving in almost every case the report that the milk was from dairy No. 1.

On the strength of this dramatically striking evidence, the proprietor of the dairy was notified that suspicion was attached to his milk as the source of infection, and was requested to use every effort to safeguard his customers. This he did with promptness, calling in at once a well-known sanitary expert to inspect the dairy and advise him as to additional safeguards. Within four days from the date of the meeting at which suspicion was first directed to his dairy, the proprietor had complied with the most essential changes recommended to him, namely, he had abandoned the "flash" system of pasteurization (165° F. from 2½ to 3 minutes) and installed apparatus enabling him to hold all milk at 145° F. for 30 minutes. He also began immediately to pasteurize his cream, which up to this time had been distributed unpasteurized. For his prompt action in this respect and for his hearty, frank cooperation with the health authorities in their investigations the proprietor of this dairy deserves great credit.

About this time the writer was detailed by the Surgeon General of the Public Health Service to proceed to Baltimore and cooperate with the State and city health authorities in an investigation of the extent and sources of this epidemic.

For the data here presented, collected from the physicians of Baltimore and vicinity through the Baltimore department of health, I am indebted above all to Dr. C. Hampson Jones, assistant commissioner of health, who not only placed the machinery of his office at my disposal, but devoted a considerable amount of his own time and effort to the investigation. For the records of bacteriologic examinations of milk and other similar data I am indebted to Dr. William Royal Stokes, director of the laboratories of the city and State health departments, to his associates, and to Dr. F. C. Blank, director of the chemical laboratory. I wish also to express my grateful acknowledgment of the cooperation and assistance of a number of Baltimore physicians. Especially am I indebted to Dr. Louis P. Hamburger for his carefully collected records of about 90 cases and for his interest and assistance in the study.

Before endeavoring to present the data collected it may be well to mention several unavoidable difficulties which were encountered in the investigation and some consequent limitations to this report.

---

[1] Winslow, C.-E. A.: Journ. Infec. Diseases, January, 1912, vol. 10, p. 73-112.

First, there was the difficulty of obtaining reports of cases, since physicians are under no legal requirement to report cases of this infection to the health department. The obtaining of voluntary records was rendered the more difficult because the study was undertaken several weeks after the acme of the epidemic. And, finally, perhaps the greatest difficulty of all was that of differentiating the cases properly belonging to this epidemic from unrelated cases of the more usual throat infections. Typical severe cases of the prevailing septic sore throat differed so radically from the other more common forms of tonsilitis and pharyngitis that hardly any of the physicians who had occasion to see such cases doubted that they were dealing with an infection new in their experience. The milder forms, however, merged into clinical pictures indistinguishable from ordinary tonsilitis, pharyngitis, and grippe, being very often recognizable as septic sore throat only because of their close association with cases of the severe type.

As the outbreak occurred at a season when other respiratory infections were at their maximum prevalence, it was inevitable that any census of cases would be subject to considerable error, by the inclusion, on the one hand, of unrelated cases of tonsilitis, grippe, etc., and by the omission, on the other hand, of mild cases of the epidemic infection. Notwithstanding these difficulties, the investigation was undertaken in the belief that the unavoidable error would not be sufficient to obscure altogether the origin of the outbreak, since most of the physicians who had seen cases of the septic sore throat felt fairly confident of their ability to distinguish it.

NATURE OF THE EPIDEMIC.

It was of prime importance to determine, first of all, whether the outbreak represented an epidemic of a single specific infection, or merely an unusual increase in the prevalence of various endemic infections. Physicians who had seen large series of cases were pretty thoroughly convinced by their clinical similarity and sudden appearance that they were the result of a single specific infection. Unfortunately, however, the study was undertaken too late for the collection of material for bacteriological study. Practically the only information available as to the bacteriology of the outbreak was such as was given verbally by several bacteriologists in Baltimore who had isolated and studied cultures from a series of cases. Their cultures were obtained from the throats of patients in the acute stage of infection, from incised glands, from the middle ear of cases complicated with otitis, from the peritoneal cavity of cases resulting in peritonitis, and, in at least one case, from the blood during life.

The various observers all agreed that the organism found predominant in the throat, and obtained in pure culture from the internal organs, was a Gram-positive streptococcus, occurring in pairs or short chains, rather closely resembling the pneumococcus, having, like the latter, an apparent capsule. This streptococcus grew readily on ordinary media, such as agar, bouillon, and Loeffler's blood serum.

As to the further identification of cultures, the methods employed were various and observations more or less conflicting, so that while it seems probable that the cultures isolated by different workers were the same, their identity does not appear to have been fully established. Also, while the pretty constant occurrence of a rather unusual variety of streptococcus in connection with so many cases indicates most strongly that the disease was a specific streptococcus infection, there remains at least the possibility that the streptococci were of secondary importance, as in measles and scarlet fever.

From the suddenness of the outbreak, the grouping of cases, the characteristic clinical manifestations, and the highly suggestive, if not conclusive, evidence of a characteristic bacterial flora in the cases studied, it appears fairly well established that the cases constituting this epidemic were due to one specific infection.

SOURCES OF INFORMATION.

To obtain records of cases the commissioner of health addressed a circular letter to each of the physicians of Baltimore and to a number of those in the immediate vicinity. This letter, giving a brief description of the clinical features characteristic of the infection, requested a report of all such cases as had come to the physicians' notice. In order to make the reporting of cases as simple as possible no information was requested except the name, age, sex, address, and date of attack of each patient; and an addressed return envelope was inclosed. Inquiry was also made as to whether an unusual prevalence of ordinary sore throat had been noted.

While awaiting returns from the circulars a personal canvass was made among as many as possible of the physicians who were most readily accessible and who were considered most likely to have seen a large number of cases. Also, the death certificates for 1912 were carefully examined in search of certificates giving as the cause of death tonsilitis, erysipelas, septicemia, or primary peritonitis.

From about 1,200 letters given out, 190 replies were received, including reports from a number of physicians personally interviewed. Of the 190 physicians who submitted reports 88 stated that they had seen no cases such as described. From the remainder, reports were received of 602 cases. It is evident that this figure can not be considered as representing even approximately the total number of cases in the outbreak since less than one-sixth of the physicians of the city made reports. Several of those who reported cases stated that they had seen a considerably larger number than reported, and a considerable number who failed to reply to the circular stated verbally that they had seen many cases during the outbreak.

From the insufficient data obtainable it is almost useless to attempt an estimate of the total number of cases in the outbreak. It was almost certainly more than 1,000, and very probably as great as 2,000, or even 3,000. Notwithstanding that the reports received were so evidently deficient, it is believed that they represent a sufficiently fair sample to furnish the basis for a satisfactory epidemiological study.

GEOGRAPHIC DISTRIBUTION.

The cases of which record was obtained were reported by physicians living in all sections of the city, and yet the cases themselves were by no means uniformly distributed. A very disproportionate number were reported from the better residence sections of the city, in the north and northwest, and the largest proportion in any one section from Roland Park, a wealthy suburb immediately adjacent to the northern city limits. From the poorer residence sections of the city a distinctly smaller number and proportion of cases were reported. This may be explained partly by the fact that among the poorer classes the cases came less regularly under the care of physicians and that many cases from these sections were treated at dispensaries or by physicians at their offices, often without any record being made. Several physicians having large practices in the southern part of the city stated that they had seen, in their offices, a great many such cases, of which they had kept no record. But even making allowance for the above considerations, it is fairly evident that the outbreak was actually more intense in the best residence sections.

As to the occurrence of cases outside of Baltimore, no very definite information has been obtained. As already stated, there was an outbreak in Roland Park, proportionately even more severe than in Baltimore, and approximately coincident with the Baltimore outbreak. Since Roland Park is contiguous to Baltimore, it is, for the purposes of this report, considered as a part of the city. Certainly some cases occurred also in the more distant suburbs, as Mount Washington, Catonsville, and Arlington, but it has been impossible to ascertain at all accurately the extent, intensity, or chronology of the outbreaks in these outlying villages. It is apparent, however, that the epidemic was fairly definitely limited to Baltimore city and to the villages nearby, in close communication with the city. Inquiry among physicians in Washington, D. C., failed to discover any evidence of a similar outbreak there.

CHRONOLOGY OF THE EPIDEMIC.

The time of occurrence of the reported cases in which dates of onset could be determined with reasonable accuracy is shown in the following tabulation (Table No. 1) and the accompanying chart (No. 1):

TABLE 1.—*Showing the time of onset of reported cases, by 10-day periods.*

Period.	Number of cases reported.	Period.	Number of cases reported.
Dec. 2-11	7	Mar. 1-10	108
Dec. 12-21	1	Mar. 11-20	75
Dec. 22-31	1	Mar. 21-30	41
Jan. 1-10	4	Mar. 31-Apr. 9	11
Jan. 11-20	14	Apr. 10-19	....
Jan. 21-30	13	Apr. 20-May 10	5
Jan. 31-Feb. 9	29		
Feb. 10-19	57	Total	[1] 535
Feb. 20-29	169		

[1] In the remainder of the 602 cases, the dates of onset were not given with sufficient definiteness to permit their inclusion in the tabulation.

A more detailed picture of the course of the epidemic is given in chart No. 4 (p. 1894) showing the onset of cases by days.

The outbreak was fairly explosive in character. Cases were few and scattering throughout December and January; they began to increase rapidly about the 1st of February, reaching their maximum in the last 10 days of this month, then decreasing throughout the month of March, steadily but less abruptly than they had increased in February. Some error is undoubtedly introduced by the inclusion, in the record, of cases of endemic respiratory infections, clinically similar to those of the epidemic proper, yet probably due to altogether unrelated causes. The effect of such cases upon the curve of the epidemic would be most probably to lessen its abruptness. A fairly constant, comparatively small number of etiologically distinct cases would obviously make a relatively greater difference in the curve of the epidemic before and after its apex.

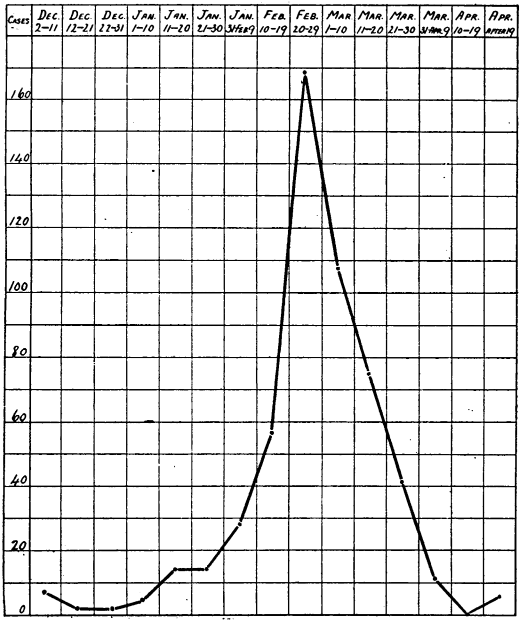

Chart No. 1.—Showing incidence of septic sore throat in Baltimore and Roland Park, by 10-day periods.

It is probable too, that in the figures for December, January, the latter part of March, and April there is a relatively larger number of erroneously reported cases than during February and the first half of March. Yet cases indistinguishable from those occurring during the height of the epidemic were reliably reported as early as December, 1911, and as late as May. The impression conveyed by the chart, that an infection, present in the city, but not excessively prevalent during December and January, suddenly became epidemic during the latter part of February and lingered through March and April is most likely correct. It is probable, too, that the prevalence of the infection continued into April to a somewhat greater extent than is shown by the figures given, for the physicians' reports were received, for the most part, about the first part of April, and later cases were not often reported, although it was said that a good many cases did occur after that time.

AGE AND SEX OF CASES.

In Table No. 2 the reported cases are classified according to age and sex.

Children under 16 years of age constituted a little less than one-half of all the cases. Making due allowance, however, for the fact that far less than half the total population are under 16 years of age, the incidence in children was relatively greater than among adults. More females than males were attacked. Among children the incidence in males and females was almost the same, while among adults it was about two and one-half times greater in females than in males.

TABLE No. 2.—*Showing the age and sex of reported cases.*

Age.	Male.	Female.	Sex unknown.	Total.
Under 1 year	3	5	3	11
1-5 years	65	55	39	159
6-10 years	34	28	7	69
11-15 years	10	14	1	25
16-20 years	10	16	1	27
21-30 years	22	45		67
31-40 years	7	38	1	46
41-50 years	10	15		25
51-60 years	4	4		8
Over 60 years	4	9		13
Children (age not specified)		1	19	20
Adults (age not specified)	32	86	2	120
Age not given			12	12
Total	201	316	85	602
Total under 16 years of age	112	103	69	284
Total over 16 years of age	89	213	4	306
Age not given				12
Total	201	316	73	602

ORIGIN AND MEANS OF DISSEMINATION OF THE EPIDEMIC.

Before this investigation was undertaken, evidence had been collected by Dr. Hamburger and other physicians sufficient to point very suggestively to one of the large dairies in the city, dairy No. 1, as a very important factor in the dissemination of the infection. Therefore, in seeking the cause of the outbreak, special attention was paid to the milk supply, more particularly to the relation of cases to the milk from dairy No. 1, with all due effort, at the same time, to trace other possible factors in the infection.

As many as possible of the reported cases were either visited by the writer or by the health wardens of the department of health for a personal inquiry into the circumstances and sources of infection. In cases which could not be personally investigated such information as was available was obtained from the attending physicians, especially in regard to the milk supply. Dr. Hamburger very kindly furnished, with his list of cases, the data carefully collected by him in regard to their milk supply, and similar information was furnished by Dr. M. Gibson Porter, of Roland Park in regard to a large group of cases reported by him.

To further show the relation between the incidence of cases and the use of milk from dairy No. 1, a list of the customers of this dairy, submitted by the proprietor, was indexed in such a way as to be easily compared with the list of reported cases of septic sore throat, furnishing fairly accurate information as to the proportion of cases occurring in families using the milk from this dairy.

I. ANALYSIS OF CASES PERSONALLY INVESTIGATED.

In the personal investigation of cases inquiry was made as to the severity and duration of illness; the sanitary conditions of the patients' residences; the chances for the infection of the first case in each family to have been contracted by contact with previous known cases; the number of persons exposed to contact infection from the first case in each family, and the incidence of the disease among them; the use and sources of milk, cream, and ice cream, and of such fruits and vegetables as are eaten raw. The suggestion having been made that the infection, though seldom accompanied by an eruption, might be an abortive form of scarlet fever, inquiry was made as to a previous attack of the latter.

In this investigation the case card shown below was used:

[Face of card.]

This side for first case in house.

Case Number.......................... Doctor..............................

CASE CARD, SEPTIC SORE THROAT.

Name of patient.......................... Age...... Sex...... Race..........
Address at onset........................ Date of onset...........................
Occupation......................... Place...................................
Duration of illness......days. Complications.......................................
Bacteriologic examination..
Termination...

ENVIRONMENT.

Number of families in building...
General sanitary conditions: Excellent? ..... Good? ..... Fair? ..... Poor? .....

NUMBER OF PERSONS IN PATIENT'S FAMILY (INCLUDING PATIENT).

Adults: Males, number................ Females, number.......................
Children:
Males, age of each...
Females, age of each...
Servants: Resident, number........... Nonresident, number.....................
Name and address of nonresident servants:
Name........................... Address................................
Name........................... Address................................
Has patient ever had scarlet fever? .... When..............................
School attended:
By patient............................... Grade..................
By others in family............................ Grades.................
Had patient been associated with any case of sore throat?............................
If so, give date, name, and address of cases...
Did patient use milk? .... Cream? .... As beverage? ....
On cereals, etc.? .... In hot drinks only? ....
Source of milk and cream...
Had any meals been taken away from home within two weeks? ....
Where? .... Was milk or cream used? ....
Source of this milk or cream...
Ice cream: Use?........... Source: ....
What was source of supply for fruits and vegetables such as are eaten raw? ....
....

[Reverse of card.]

LATER CASES IN SAME FAMILY.

1. Name: .... Age: ...... Sex: .... Date: ....
Occupation: .... Place: ....
Use of milk and cream?................ Source: ....
Remarks: ....
2. Name: .... Age: ...... Sex: .... Date: ....
Occupation: .... Place: ....
Use of milk and cream? .... Source: ....
Remarks: ....
3. Name: .... Age: ...... Sex: .... Date: ....
Occupation: .... Place: ....
Use of milk and cream?................ Source: ....
Remarks: ....
How many of those who were not sick used milk and cream?.........................
Adults, number: .... Children, number: ....
Cases among neighbors and associates: ....
....
....
....

Remarks:

Record obtained by......................., ..., 1912.

Records were obtained in this way of 191 cases, occurring in 105 families. It was apparent, from the histories obtained, that some of these were not true cases of septic sore throat, but, except in two or three instances, no effort was made to revise the diagnosis; and for the sake of uniformity with the other cases, reported but not investigated, the records of the clinically doubtful cases were included under the original diagnosis of the attending physician.

Information as to a previous attack of scarlet fever was obtained from 103 patients, of whom 15 gave a definite history of having previously had scarlet fever. A previous attack of scarlet fever does not, therefore, confer immunity to this disease, which may accordingly be considered as a distinct infection.

GEOGRAPHIC AND CHRONOLOGIC DISTRIBUTION OF INVESTIGATED CASES.

The group of investigated cases, selected somewhat arbitrarily from the total number of reported cases, is believed to be fairly representative. Their geographic distribution was approximately proportionate to the distribution of the total reported cases, except that none of the cases reported from Roland Park were visited. This omission was intentional, as the data given by the reporting physicians for the cases in that section were more specific than for most of the city cases.

The cases investigated included a fair proportion of those occurring in the different periods of the epidemic, as shown in Table No. 3.

TABLE No. 3.—*Showing the number and proportion of reported cases investigated, according to date of onset.*

Date of onset.	Number of cases reported.	Number investigated.	Per cent investigated.
Dec. 2-11	7		
Dec. 12-21	1		
Dec. 22-31	1		
Jan. 1-10	4	1	25.0
Jan. 11-20	14	2	14.3
Jan. 21-30	13	2	15.3
Jan. 31-Feb. 9	29	6	20.7
Feb. 10-19	57	27	47.3
Feb. 20-29	169	48	28.4
Mar. 1-10	108	50	46.3
Mar. 11-20	75	31	41.3
Mar. 21-30	41	9	22.0
Mar. 31-Apr. 9	11	3	27.0
Apr. 10-19			
After Apr. 19	5	1	22.0
Date not definitely given	67	11	16.4
Total	602	191	30.5

CONTACT INFECTION.

One of the first factors to be considered in the dissemination of an epidemic of this nature is contact with infected persons.

The 191 investigated cases occurred in 105 families, as follows:

	Cases.
1 case in family, 62 families	62
2 cases in family, 18 families	36
3 cases in family, 13 families	39
4 cases in family, 18 families	72
5 cases in family, 3 families	15
7 cases in family, 1 family	7
Total (105 families)	191

There were then 86 (191 − 105 = 86) cases which occurred in famiies when there had been one or more previous or simultaneous cases. In these 86 cases the dates of onset of the primary and subsequent cases in the same households were as follows:

TABLE No. 4.—*Showing intervals between first case and subsequent cases in families in which two or more cases occurred.*

	Cases.		Cases.
Same day	14	8-14 days	19
1 day	3	15-30 days	17
2 days	5	31-60 days	3
3 days	5	Over 60 days	2
4 days	4	Interval not stated	6
5 days	1		
6 days	4	Total	86
7 days	3		

The 14 cases which occurred on the same day as the earliest cases in the respective families can more properly be considered as "primary" rather than "secondary" cases. As for the remaining 72 cases, while it is not proven that they were contracted through contact-infection from previous cases in the same families, the probability of their having been so contracted can not be excluded, since they must obviously have been exposed to infection in that way.

Of the 119 cases which may be considered "primary"—that is, the earliest cases in their respective families—only 17 gave any history of previous contact with recognized cases of sore throat, and in the majority of these instances the previous cases with which there had been contact were mild, apparently ordinary cases of tonsilitis.

An analysis of the cases with reference to the schools attended shows that 40 patients, from 35 families, were attending schools at the time of onset of illness. These 40 cases were distributed among 24 schools, the largest number of patients attending any one school being 3. The absence of significant grouping of cases in any of the schools or of any disproportionate incidence among school children as compared with infants and adults is fairly good evidence that the schools were not a factor of prime importance in the spread of the infection.

Although close inquiry has failed to reveal any evidence of the disease having spread to any considerable extent from family to family by contact with previous recognized cases, there is rather good evidence that the infection once introduced into a household was disseminated within the family to some extent by contact; also, that mild cases and very probably "carriers," in apparently good health, were factors of considerable importance in the dissemination of the infection to other families. As a discussion of these questions here would necessitate anticipating some data bearing upon them, they will be taken up in another section.

RELATION TO MILK SUPPLY.

The use of milk or cream by patients within the 30 days preceding their illness was determined as follows:

Raw or commercially pasteurized milk without home sterilization was habitually taken as follows:

As a beverage, in 95 cases, or 53.1 per cent.
On cereals, etc., but not as a beverage, in 33 cases, or 18.4 per cent.
Taken, but extent not stated, in 14 cases, or 7.8 per cent.
Only in hot drinks (tea, coffee, etc.), in 10 cases, or 5.7 per cent.
Not at all, in 27 cases, or 15 per cent.
Use of milk not determined in 12 cases.

Approximately 20 per cent of the patients from whom information was obtained used no milk at all, or used it to such a slight extent, in hot drinks, as to make it improbable that they were exposed to infection from the milk taken. The remaining 80 per cent took milk in sufficient amounts to have been exposed to probable infection with such pathogenic germs as it might contain. The percentage of milk users is somewhat higher than would be expected if milk were not a factor in the spread of the infection, yet not sufficiently high to be of itself definitely significant.

TABLE No. 5.—*Showing sources of milk supply of families in which cases of septic sore throat occurred.*

Source.	Number of families.	Number of cases.
Dairy No. 1	43	90
Dairy No. 1 and 2	2	5
Dairy No. 1 and 3	6	16
Dairy No. 1 and 4	1	2
Dairy No. 1 and 9	1	2
Dairy No. 1 and various	2	4
Dairy No. 1 and 22	1	5
Total receiving milk from dairy No. 1	56	124
Dairy No. 2	8	10
Dairy No. 2 and various	2	4
Dairy No. 4	5	7
Dairy No. 4 and various	1	1
Dairy No. 5	3	3
Dairy No. 6	2	2
Dairy No. 7	2	3
Dairy No. 8	1	4
Dairy No. 9	1	3
Dairy No. 10	1	2
Dairy No. 11 to 21 inclusive	11	11
Neighbor	1	1
Various	3	4
No milk supply or used condensed milk only	8	12
Grand total	105	191

Approximately 53 per cent of the families, comprising 65 per cent of the cases investigated, obtained their milk supply wholly or in part from dairy No. 1. The remaining 41 families (39 per cent) having a known and regular source of milk supply obtained their milk from at least 20 different sources, including 19 dairies, mostly of considerable size. The largest number of families supplied by any one of these dairies was 10 (comprising 14 cases) by dairy No. 2, which is by far the largest dairy in the city. Dairy No. 4, which supplied 6 families, is the next largest of the city's dairies.

None of the other dairies had a significant number of cases among their customers, except dairy No. 5, a small dairy supplying 3 families.

It is estimated, from the figures of the Baltimore department of health, that dairy No. 1 supplied at that time about 3.3 per cent of the milk sold in Baltimore. It is, therefore, hardly conceivable that mere coincidence could account for the fact that 65 per cent of these cases of septic sore throat were in families supplied by this one dairy. The presumption that this milk was an important source of infection in the 56 families using it is so strong as to demand a careful study of the cases in these families with reference to their consumption of the milk.

ANALYSIS OF CASES IN FAMILIES OBTAINING MILK FROM DAIRY NO. 1.

An analysis of the information as to the consumption of milk by the 124 patients in these 56 families obtaining milk from dairy No. 1, brings out more clearly the relation between the incidence of infection and the use of this milk. The milk was used as follows:

60 patients, or 52.6 per cent, had used this milk as a beverage.
25 patients, or 21.9 per cent, had used it on cereals, etc., but not as a beverage.
1 patient, or 0.9 per cent, had used it in ice cream only.
13 patients, or 11.4 per cent, had used it, but to what extent was not stated.
2 patients, or 1.87 per cent, had used this milk only after resterilization at home.
3 patients, or 2.67 per cent, had used this milk only in hot tea or coffee.

4 patients, or 3.5 per cent, had used only the milk of another dairy, although the rest of the family used milk from Dairy No. 1.
6 patients, or 5.3 per cent, had not used milk in any way.
A total of 99, or 86.8 per cent, had used this milk without heating.
A total of 15, or 13.2 per cent, had used this milk only after heating or had not used it at all.
In 10 cases no information was available as to the use of milk and cream.

From the above analysis it is seen that the great majority of the cases in these families (99 or 86.8 per cent) were in persons who used this milk unheated. A considerable proportion of the patients (15 or 13.2 per cent), however, either used none of the milk from dairy No. 1 or used it only after it had been heated. These 15 cases may now be taken up in detail.

Two children in two separate families drank this milk only after it had been carefully sterilized at home. One of these children had been exposed to contact infection from two previous cases in the same family, in older persons who used the milk without sterilization. The other child had gone frequently to visit at the house of a relative where several adults who used milk from dairy No. 1 were sick with severe cases of septic sore throat.

Of the four patients who used only a separate milk supply, from another dairy, three had been exposed to earlier cases in their respective families, in older persons who used milk from dairy No. 1. In the family of the fourth child there had been no previous case reported as septic sore throat, but the mother, who used milk from dairy No. 1, stated that she had suffered an attack of tonsillitis two weeks prior to the child's illness.

Of the three cases in persons who used this milk only in hot tea or coffee, one was subsequent to other cases in the same family. The other two were the first cases in their respective families, and can not be accounted for by contact infection from any other known cases at their homes or elsewhere. Since the amount of milk commonly taken in the tea or coffee is small and the temperature to which it is usually raised may be expected to destroy most, if not all, of the pathogenic germs which may be present, the chances of contracting infection from milk taken in this way are relatively slight, yet not altogether negligible, for the amount of milk taken in this way and the temperature to which it is raised are quite variable.

In regard to the six patients who had not used milk in any way. four had been exposed to infection from previous cases of septic sore throat among milk users in their own families. The two remaining cases can not be accounted for by any known exposure to contact infection.

Summarizing the 15 cases just reviewed, 2 of them may perhaps be accounted for by milk infection from milk taken in tea or coffee, 10 can be accounted for by exposure to a previous case recognized as septic sore throat, and 1 by exposure to an unreported case of tonsilitis, leaving 2 in which no apparent source of infection could be traced. Every other patient in this group of 124 cases had either used milk from dairy No. 1 or been associated with previously infected persons.

The group of cases in the families supplied by dairy No. 1 may be further analyzed with respect to the earliest case in each family, thus giving a clearer idea of how the infection was introduced into the various families.

TABLE No. 6.—*Showing the use of milk by persons first attacked with septic sore throat in each of the 56 families obtaining their milk supply wholly or in part from dairy No. 1.*

Number of families.	Source of milk used by person first attacked.	Use of milk by person first attacked in each family.
47	Dairy No. 1	As a beverage or on cereals, etc.
1	do	Only as ice cream.
1	do	To what extent was not ascertained.
2	do	Only in hot tea or coffee.
1	do	Only after repasteurization at home. (Definite history of intimate exposure to several previous cases of septic sore throat in another family where this milk was used without repasteurization.)
1	Used only milk from another dairy, though rest of family used milk from dairy No. 1. The mother of this patient used milk from dairy No. 1 and had previously suffered a slight attack of tonsillitis, not reported as septic sore throat.	
2	Used no milk at all	
1	No information obtained as to use of milk by patient first affected.	

From the foregoing analyses the following conclusions may be drawn:

1. The proportion of cases among families supplied with milk from dairy No. 1 is so great as to point almost unmistakably to the conclusion that this milk was a large factor in the spread of the infection.
2. In the families supplied by dairy No. 1 most of the cases (86.8 per cent) were in persons who used this milk rather freely; but a considerable portion of the patients (13.2 per cent) were pretty definitely known not to have used any of this milk without heating.
3. In most of the latter cases, where direct infection from the milk could be excluded, the patients had been intimately associated with previously infected persons who had used this milk.
4. It would appear, then, that in the families supplied by dairy No. 1 two factors entered into the incidence of infection, namely, the use of infected milk from dairy No. 1, and contact with persons previously infected in this way. The number of cases which can not be accounted for in either of these ways is so small as to be reasonably attributable to error.

ANALYSIS OF CASES IN FAMILIES NOT KNOWN TO HAVE OBTAINED MILK FROM DAIRY NO. 1.

To take up now the cases in families not known to have been supplied with milk from dairy No. 1, one of these patients is known to have drunk milk from dairy No. 1 away from home. In a number of other instances milk from unknown sources had been used either at home or in visiting. It is rather probable that in some of these instances the milk was from dairy No. 1, but it is not likely that the occasional, unknown use of milk from this source was responsible for more than a very few cases. Nor is there evidence that any of the dairies supplying milk to these families were sources of infection, since it is altogether improbable that they should all have been infected at once, and there is no significant disproportion of cases among the customers of any one of them.

Evidence that the use of milk was a less important factor in the infection of these cases than in those which occurred in families supplied by dairy No. 1, is furnished by an analysis of the cases in regard to the extent of the use of milk.

Deducting the one case in a person known to have used milk from dairy No. 1, away from home, there remain 66 cases in 48 families not known to have received any part of their milk supply from this dairy. The use of milk as determined in these cases was as follows:

Milk was used as a beverage in 27 cases, or 42.2 per cent.
Milk was used on cereals, etc., not as a beverage in 10 cases, or 15.6 per cent.
Milk was used, extent not stated, in 1 case, or 1.6 per cent.
Milk was used only in hot drinks in 7 cases, or 10.9 per cent.
No milk at all was used in 19 cases, or 29.7 per cent.
No information was obtained in 3 cases.

Comparing the above with the similar analysis of cases in families supplied by dairy No. 1, it is seen that a much larger percentage of the latter (86.9 per cent against 59.4 per cent) were in persons who used unheated milk rather freely. Also, while only 5.2 per cent of the cases among the customers of dairy No. 1 were in persons who used no milk at all, 29.7 per cent of the patients in this group used none.

Table No. 7, with chart No. 2, shows a very striking and significant difference between the cases among customers of dairy No. 1 and those in other families in regard to the dates of onset of illness.

TABLE NO. 7.—*Showing dates of onset of investigated cases of septic sore throat among customers of dairy No. 1 and in other families.*

Time of onset.	Cases in families supplied by dairy No. 1.	Cases in all other families.	Total cases.	Percentage of total cases among customers of dairy No. 1.
1912.				
Jan. 1-10	....	1	1	....
Jan. 11-20	....	2	2	....
Jan. 21-30	1	1	2	50
Jan. 31-Feb. 9	3	3	6	50
Feb. 10-19	20	7	27	74
Feb. 20-29	41	7	48	85.4
Mar. 1-10	33	17	50	66
Mar. 11-20	13	18	31	41.9
Mar. 21-30	3	6	9	33.3
Mar. 31-Apr. 9	1	2	3	33.3
Apr. 10-19	....	....	....	....
Apr. 20-29	....	....	....	....
Apr. 30-May 9	1	....	1	100
After May 9	....	....	....	....
Date not given	8	3	11	....
Total	124	67	191	64.9

From the foregoing it is evident that the outbreak occurred first among the families supplied by dairy No. 1 and had already begun to decline among them before it reached its maximum prevalence in the other families considered. This fact, in connection with the occurrence in families supplied by dairy No. 1 of some cases apparently attributable only to contact infection, strongly suggests that the outbreak among families not using this milk was a "secondary" contact-epidemic.

Another difference very distinctly appreciable between the group of families obtaining their milk supply from dairy No. 1 and those obtaining it from other dealers, is that in the former group multiple cases in the families were more common.

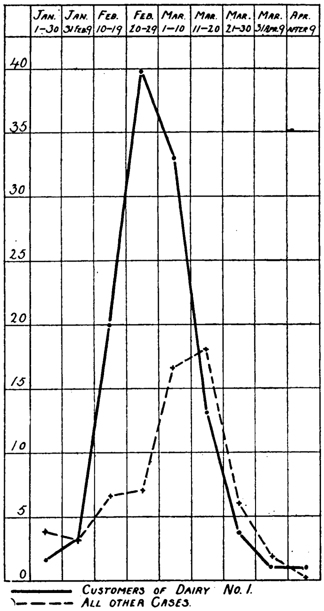

CHART No. 2.—Showing chronological incidence of 191 investigated cases of septic sore throat; dates of onset by 10-day periods.

The distribution of cases in families is shown in the following tabulations:

Incidence of septic sore throat in families supplied with milk wholly or in part from dairy No. 1.

	Cases.
1 case in family, 25 families	25
2 cases in family, 10 families	20
3 cases in family, 11 families	33
4 cases in family, 6 families	24
5 cases in family, 3 families	15
7 cases in family, 1 family	7
Total, 56 families	124

Average number of cases per family, 2.21.

Approximately 80 per cent (99) of these cases occurred in families with more than one case each.

Incidence of septic sore throat in families obtaining their milk supply from dealers other than dairy No. 1.

	Cases.
1 case in family, 37 families	37
2 cases in family, 8 families	16
3 cases in family, 2 families	6
4 cases in family, 2 families	8
Total (49 families)	67

Average number of cases per family, 1.37.

Thirty (44.8 per cent) of the cases occurred in families with more than one case each.

From these comparisons it is evident that the infection was more intense in the families supplied with milk from dairy No. 1, suggesting larger dosage or greater virulence of the infective agent.

Tables Nos. 8 and 9, showing the attack rates per hundred in families supplied by dairy No. 1 and in the other families are presented to illustrate two facts: First, the higher percentage of persons sick in the families supplied by dairy No. 1; and, second, in both groups, the relatively greater incidence in children than in adults, and the greater incidence in adult females than in adult males.

TABLE No. 8.—*Showing the attack rates per 100 in males and females of various age groups in families obtaining their milk supply wholly or in part from dairy No. 1.*

Age groups.	Males.			Females.			Total.		
	Number.	Number sick.	Attack rate per 100.	Number.	Number sick.	Attack rate per 100.	Number.	Number sick.	Attack rate per 100.
10 years and under	40	29	74.0	33	33	100.0	73	62	84.9
11 to 20 years	8	5	62.5	6	4	66.6	14	9	64.3
Over 20 years	69	13	18.8	104	31	29.8	173	44	25.4
Total	117	47	40.0	143	68	47.5	260	115	44.2

NOTE.—Servants are not included in the above table because of the difficulty of obtaining accurate information concerning them. It is the omission of these that reduces the number of cases from 124 to 115.

TABLE No. 9.—*Showing the attack rates per 100 in males and females of various age groups in families obtaining their milk supply from dealers other than dairy No. 1.*

Age groups.	Males.			Females.			Total.		
	Number.	Number sick.	Attack rate per 100.	Number.	Number sick.	Attack rate per 100.	Number.	Number sick.	Attack rate per 100.
10 years and under	32	17	53.1	27	16	59.2	59	33	55.9
11 to 20 years	8	2	25.0	17	4	23.4	25	6	24.0
Over 20 years	88	11	12.5	105	16	15.2	193	27	14.0
Total	128	30	23.4	149	36	24.1	277	66	23.8

NOTE.—Servants not included.

It has already been stated that some of the cases included in the records did not appear to have been true cases of the epidemic septic throat infection, but ordinary tonsillitis. As by far the most of these doubtful cases were in the group of families not customers of dairy No. 1, a more rigid clinical differentiation would have left even a larger proportion of cases among the customers of dairy No. 1.

The duration of illness was ascertained in 64 of the cases in families supplied by dairy No. 1 and in 54 of the cases in other families. The average duration in the former group was 18.9 days, as compared to an average of 13.1 in the latter.

The table following shows the greater proportion of prolonged cases among the customers of dairy No. 1.

TABLE No. 10.—*Showing duration of illness in cases of septic sore throat.*

Duration of illness.	Cases in families supplied by dairy No. 1.	Cases in families not supplied by dairy No. 1.
1 to 7 days	19 cases or 29.5 per cent	20 cases or 37.2 per cent.
8 to 14 days	13 cases or 20.4 per cent	24 cases or 44.4 per cent.
15 to 21 days	15 cases or 23.5 per cent	4 cases or 7.4 per cent.
22 to 28 days	4 cases or 6.2 per cent	1 case or 1.8 per cent.
Over 28 days	13 cases or 20.4 per cent	5 cases or 9.2 per cent.
Total	64 cases or 100 per cent	54 cases or 100 per cent.
Total in 1-14 days	32 cases or 50 per cent	44 cases or 82.6 per cent.
Total over 14 days	32 cases or 50 per cent	10 cases or 18.4 per cent.

Over half the cases among customers of dairy No. 1 were of more than 2 weeks' duration, while less than one-fifth of the other cases were of such long duration.

Inquiry was also made as to the severity of illness and its complications. Analysis of the information obtained in regard to 80 cases among customers of dairy No. 1 and 51 cases in other families shows in the former group a higher proportion of severe cases with serious complications, as follows:

Complications.	Cases among customers of dairy No. 1 (exclusive of fatal cases).	Cases in families not customers of dairy No. 1 (exclusive of fatal cases).
Adenitis	31 cases	10 cases.
Otitis	7 cases	2 cases.
Arthritis	3 cases	
Erysipelas	1 case	
Septicemia	1 case	
Abscess of tonsils	1 case	1 case.
Neuritis	1 case	
Nephritis		1 case.
Severe cases, complications not specified	7 cases	1 case.
Total severe or complicated cases	52 cases, or 65 per cent	15 cases, or 29.4 per cent.
Total uncomplicated or mild cases	28 cases, or 35 per cent	36 cases, or 70.6 per cent.
Grand total	80 cases, or 100 per cent	51 cases, or 100 per cent.

NOTE.—Nearly two-thirds of the cases among customers of dairy No. 1 were of severe type, usually with some complications, while less than one-third of the cases in other families could be so classified.

Summing up the evidence collected in the study of the 191 cases closely investigated, the first and most striking fact brought out is that about two-thirds of the cases were in families obtaining their milk supply wholly or in part from a single dairy. Since this dairy distributed only about 3.3 per cent of the milk sold, the number of cases among its customers is so altogether disproportionate as to indicate almost conclusively that this milk was an important factor in spreading the infection. This conclusion is further strengthened by the fact that over 85 per cent of the cases within the families taking milk from dairy No. 1 were habitual users of this milk.

On the other hand, even in these families there were some cases in persons who did not use the milk at all, and so could not have been infected in that way. In almost every one of these instances the patients had been intimately associated with previous cases of septic sore throat in persons who did use the milk. It would appear, then, that their cases were due to contact infection and that the disease is contagious.

About one-third of the cases studied were in families who obtained no part of their milk supply from dairy No. 1. These families had no common source of milk supply. Several of them used no milk at all or only condensed milk; the others purchased from at least 19 different dairies, including the largest in the city. The distribution of the cases among the customers of these dairies was generally proportionate to the amount of milk sold by each. It is, therefore, unlikely that the cases in this group were due to infection contracted from milk. As sustaining this conclusion several facts may be noted. In these families the percentage of patients who habitually used milk was not strikingly high. The infection appeared to be less intense in these families than in the families supplied by dairy No. 1, as shown by the lesser frequency of multiple cases in the families affected; also, the course of the infections was generally shorter and less severe. It is characteristic of milk-borne epidemics that several cases occur in the same family almost simultaneously.

Since it appears that the cases in families not customers of dairy No. 1 are not attributable to milk infection, it remains to consider what was their most probable source of infection. It is believed that they were due, generally, to contact infection from previous cases, chiefly among the customers of dairy No. 1. The reasons for this belief are the following:

Already, from the study of the case in families using the presumably infected milk, evidence has been brought out to show that the infection was probably contagious, capable of being spread by contact from infected persons. The outbreak of the milk epidemic among the clientele of dairy No. 1 established, in February and early March, all over the city an enormous number of foci from which infection might be spread in this way. The cases in families not supplied by dairy No. 1, occurring distinctly later than the outbreak among the customers of this dairy, give the impression of being secondary to the latter. Few of the cases outside the patrons of dairy No. 1 gave definite histories of contact with previous recognized cases, but it may be recalled that many cases belonging to the distinctly milk-borne epidemic were of very mild type. Such mild cases, and perhaps apparently healthy "carriers," mingling with their associates, would offer sufficient explanation for the widespread dissemination of infection throughout the city during and after the distinctly milk-borne epidemic.

II. ANALYSIS OF ALL REPORTED CASES.

As stated above, the total number of cases of septic sore throat reported to the commissioner of health was 602. The group of 191 cases above considered constitutes, therefore, slightly less than one-third of all the cases on record.

It was not practicable to visit all the reported cases to ascertain the source of their milk supply, nor practicable, in most instances, to obtain information on this point from the attending physicians. It was possible, however, to obtain in another way fairly accurate information regarding the connection between the whole group of cases and the milk distributed by dairy No. 1. The proprietor of this dairy, upon request, furnished to the commissioner of health a list of all customers regularly supplied by him during February and March, 1911. This list, after being properly indexed according to street addresses, was compared with the similarly indexed list of cases of septic sore throat reported by physicians to the health department. In this way information was obtained as to the number of cases occurring among the customers of this dairy.

In about half of the cases thus located on this milk route confirmatory information as to the source of milk supply was obtained by personal investigation or from physician's reports. Very little of the milk from this dairy was sold at wholesale to intermediate distributors—restaurants, drug stores, groceries, and saloons—practically all being sold direct to householders for home consumption. A list of the families regularly supplied with this milk would probably, therefore, include practically all persons who had consumed it, except the relatively few who took it for lunch at their places of business or occasionally used some of it at friends' houses. It is believed that the method employed has given a fairly accurate idea of the relation between the distribution of the milk and the occurrence of cases.

By comparing the list of reported cases with the list of customers of dairy No. 1, it was found that 410, or 68 per cent, of the 602 cases had occurred in families regularly supplied with milk from this dairy. In this whole group, therefore, as in the smaller group of cases more closely studied, approximately two-thirds of the cases were found among the customers of this one dairy, which, as already stated, distributed only about 3.3 per cent of the milk sold in Baltimore.

Some further idea of the disproportionate incidence among the customers of this dairy may be obtained from the following estimate. The population of Baltimore is about 560,000. According to the estimate of the proprietor, dairy No. 1 supplied about 3,500 customers, mostly householders. Making a liberal estimate of 6 persons in each family supplied, there were about 21,000 people to whom this milk was distributed as compared with approximately 539,000 people in Baltimore not using this milk. The 410 cases among 21,000 people are equivalent to an incidence of approximately 20 per 1,000, while the remaining 192 cases distributed among a population of 539,000 not supplied by dairy No. 1 are equivalent to an incidence of only 0.36 per 1,000.

Since it is evident that only a small part of the total cases either among the customers of dairy No. 1 or among others were reported, the above figures are only relative, but they may be accepted as showing approximately the proportionate incidence of cases.

In the group of 191 cases investigated it was found that multiple cases in the family were more common among the customers of dairy No. 1. The same is true as regards the whole group of reported cases, as shown by the following tabulations:

Incidence of septic sore throat in families supplied with milk from dairy No. 1.

	Cases.
1 case in family, 79 families	79
2 cases in family, 30 families	60
3 cases in family, 34 families	102
4 cases in family, 12 families	48
5 cases in family, 7 families	35
6 cases in family, 6 families	36
7 cases in family, 1 family	7
8 cases in family, 1 family	8
9 cases in family, 1 family	9
11 cases in family, 1 family	11
15[1] cases in family, 1 family	15
Total (173 families)	410

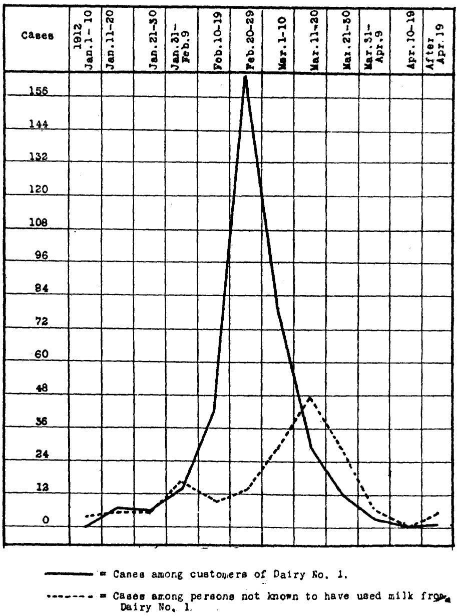

CHART No. 3.—Showing chronological incidence of cases of septic sore throat among customers of dairy No. 1, and among other families, by 10-day periods. (535 cases.)

Incidence of septic sore throat in families not supplied with milk from dairy No. 1.

	Cases.
1 case in family, 124 families	124
2 cases in family, 20 families	40
3 cases in family, 2 families	6
4 cases in family, 3 families	12
5 cases in family, 2 families	10
Total (151 families)	192

In the families supplied by dairy No. 1, the average number of cases per family was 2.37, while in families not on this milk route the number of cases per family averaged 1.26.

Again, a chronological analysis of all the reported cases shows, as did a similar analysis of the smaller group first considered, that

---

[1] These 15 cases occurred in a total of 23 persons in a nurses' home.

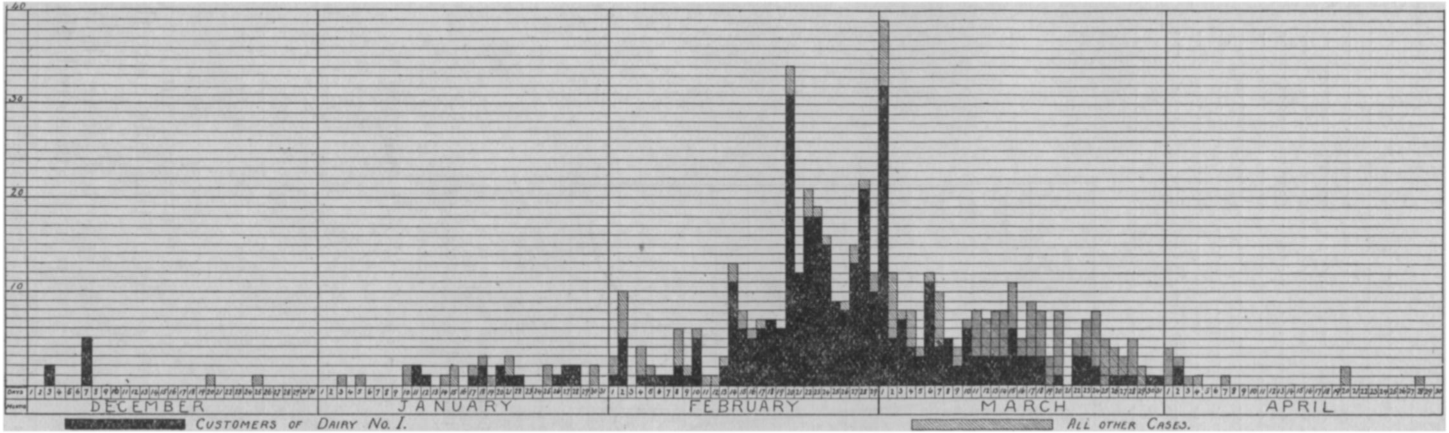

CHART NO. 4.—Showing daily incidence of cases of septic sore throat (535 in all) among customers of dairy No. 1 and other families.

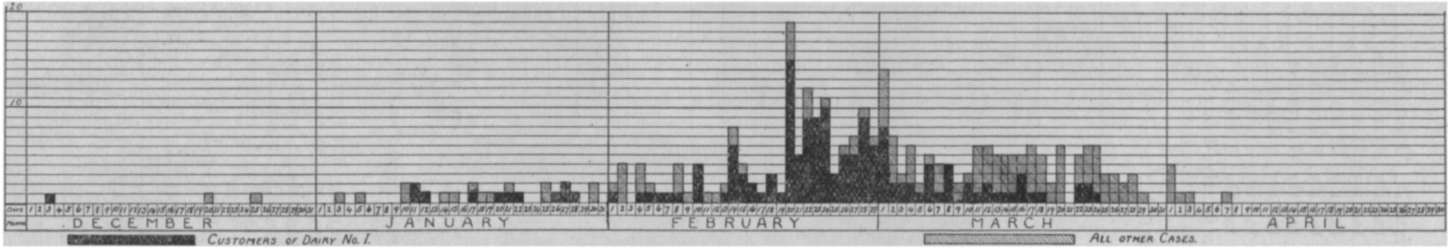

CHART NO. 5.—Showing dates of onset of first cases in each family affected.

the epidemic outbreak occurred first among the customers of dairy No. 1 and was followed by a smaller outbreak in the rest of the population, as shown in the preceding charts (Nos. 3, 4, and 5) and table (No. 11):

TABLE No. 11.—*Showing chronological incidence of cases among customers of dairy No. 1 and others, by 10-day periods.*

Period.	Cases on milk route of dairy No. 1.	Cases not on this milk route.	Total.
1911.			
Dec. 2-11	7	....	7
Dec. 12-21	....	1	1
Dec. 22-31	....	1	1
1912.			
Jan. 1-10	....	4	4
Jan. 11-20	8	6	14
Jan. 21-30	7	6	13
Jan. 31-Feb. 9	13	16	29
Feb. 10-19	47	10	57
Feb. 20-29	155	14	169
Mar. 1-10	79	29	108
Mar. 11-20	28	47	75
Mar. 21-30	12	29	41
Mar. 31-Apr. 9	3	8	11
Apr. 10-19	....	....	....
After Apr. 19	1	4	5
Total	360	175	535

NOTE.—In the remainder of the 602 reported cases the dates of onset were not given specifically.

The charts showing the onset of cases by days bring out more strikingly than do the more condensed charts some details as to the course of the outbreak.

It extended over a rather long period—approximately from the first of February to the first of April, and, if the scattering cases are included, for an even longer period. The cases not on the milk route of dairy No. 1 are both actually and relatively more numerous after the first 10 days in March, but are not confined to any one period of the outbreak occurring before, after, and all through the epidemic among the customers of dairy No. 1.

This may indicate the constant inclusion in the records of cases of tonsillitis not due to the same specific infection as the milk epidemic, or it may indicate an endemic prevalence of the same infection, which became epidemic only when a large milk supply became infected.

FATALITIES.

Records were obtained of 28 deaths during February, March, April, and May, 1912, considered by the physicians in attendance to have been due to general infection resulting from septic sore throat. In December, 1911, one death was reported as due to septicemia following a streptococcus tonsillitis. There was no evidence tending to connect this case with the outbreak of February, 1912, excepting a certain clinical similarity.

In the following table (No. 12) is given a list of the recorded fatal cases of septic sore throat, separated for convenience into two groups: (1) Fatalities in families regularly supplied with milk from dairy No. 1, and (2) fatalities in families not known to have obtained any part of their milk supply from this dairy.

TABLE No. 12.—*Showing deaths from septic sore throat.*

A. IN FAMILIES REGULARLY SUPPLIED WITH MILK FROM DAIRY NO. 1.

	Age in years.	Sex.	Date of onset.	Date of death.	Immediate cause of death.
1	3	M.	Feb. 10	Feb. 20	Septicemia.
2	29	F.	Feb. 7	Feb. 25	Peritonitis.
3	3	F.	Feb. 25	Feb. 27	Acute appendicitis, peritonitis.
4	51	F.	Feb. 26	Feb. 29	Septicemia, peritonitis.
5	64	M.	...do.....	...do.....	Peritonitis.
6	60	F.	Feb. 8	Mar. 4	Peritonitis, relapse, pneumonia.
7	$\frac{7}{12}$	M.	Mar. 6	Mar. 7	Septicemia, convulsions.
8	3	M.	Mar. 4	...do.....	Peritonitis.[1]
9	4	F.	Feb. 27	....	
10	1	M.	Mar. 4	Mar. 8	Do.
11	1	F.	Mar. 8	Mar. 11	Septicemia.
12	8	M.	Feb. 28	Mar. 12	Acute appendicitis.
13	1	F.	....	....	Septicemia, convulsions.
14	37	F.	Mar. 12	Mar. 16	Peritonitis.[1]
15	$\frac{4}{12}$	M.	Feb. 26	...do.....	Erysipelas.
16	3	F.	Feb. 28	Mar. 20	Peritonitis.[1]
17	3	M.	Mar. 11	Mar. 21	Do.
18	4	M.	Mar. 23	Mar. 27	Do.
19	1	M.	Mar. 14	Mar. 28	Septicemia, broncho-pneumonia.
20	4	M.	....	Mar. 29	Peritonitis, pneumonia.
21	65	F.	Apr. 2	Apr. 6	Septicemia.

B. IN FAMILIES NOT REGULARLY SUPPLIED WITH MILK FROM DAIRY NO. 1.

22	27	F.	Mar. 2	Mar. 7	Peritonitis.[1]
23	....	....	Mar. 9	Mar. 16	Peritonitis, convulsions.
24	$\frac{7}{12}$	F.	Mar. 13	Mar. 23	Erysipelas.
25	1	M.	Mar. 14	Mar. 29	Septicemia.
26	$\frac{1}{12}$	F.	Mar. 28	Apr. 1	Do.
27	51	F.	Apr. 15	Apr. 17	Peritonitis.
28	1	F.	May 5	May 12	Broncho-pneumonia.

[1] Diagnosis bacteriologically confirmed by isolation of streptococcus from internal organs.

In the list of fatalities given above are included only those in which the diagnosis of septic sore throat was given by the attending physicians. The diagnosis is somewhat doubtful in three or four of these cases (all in families not supplied by dairy No. 1), yet it is believed that the total number of deaths, as given, is in all probability too small rather than too large.

Several of the fatalities listed above appeared in the death records under diagnoses such as broncho-pneumonia and acute appendicitis, which would have made it impossible to recognize them, from the death records alone, as due to septic sore throat. It is by no means unlikely that deaths of which no supplementary report was made were certified under similarly obscuring diagnoses.

Of the 28 fatal cases, 21 (75 per cent) were in families obtaining their milk supply wholly or in part from dairy No. 1. In two of these cases it was definitely asserted that the patients had not used any of the milk from dairy No. 1, but in both instances other members of their families who did use this milk had been ill a short time prior with less severe attacks of the same infection. In regard to the rest of the cases in this group, it was ascertained either from members of their families or from the attending physician that the patients, prior to their illness, had habitually taken this milk either as a beverage or on cereals and desserts.

Seven fatal cases were reported in families not appearing on the list of customers of dairy No. 1. In one of these cases it was ascertained that for several weeks prior to her illness the patient had been away from home visiting friends in another part of the city, but the address of the latter family and their source of milk supply could not be ascertained. Excluding this case (No. 23, onset Mar. 2), in regard to which no information was obtainable, the others, when grouped chronologically, show a very striking relation to the milk supply of dairy No. 1.

	Total fatal cases.	Cases among customers of dairy No. 1.	
		Number.	*Per cent.*
Fatal cases having their onset prior to March 9	15	15	100
Fatal cases having their onset after March 9	12	6	50
Total	27	21	....

An analysis of the death records therefore confirms what has already been indicated by analysis of the morbidity reports, namely, that the outbreak was, in the latter part of February and the first part of March, confined almost exclusively to the customers of dairy No. 1, and later was more widely disseminated.

In the death certificates for the month of March were found records of four deaths from septic infection, among the patrons of dairy No. 1, but not included in the above list. Two of these deaths, one from erysipelas and one from lymphangitis, were considered by the attending physicians not to have been due to septic sore throat; this was thought to have been the most probable cause of one, and in regard to the fourth no information was obtainable except the death certificate. It is highly improbable that these four deaths, from such relatively rare causes, all occurring within a month among the patrons of dairy No. 1, are attributable to coincidence, independent of the prevailing epidemic.

INSPECTION OF DAIRY NO. 1.

While case records were being collected a careful inspection was made of the dairy, the product of which seemed so closely connected with the epidemic, and a history of its operations obtained from the proprietor, who gave his full cooperation in the efforts to ascertain and remove any source of infection. A short time prior to this investigation, as soon as there was any suspicion attached to his dairy, the proprietor had sought the advice of a sanitary expert whose recommendations had been faithfully carried out.

The dairy, more properly a pasteurizing plant and distributing depot, was receiving daily, during the months of February and

March, about 1,000 gallons of milk and 30 to 40 gallons of cream, which were distributed by 16 delivery wagons to about 3,500 families. Ice cream and butter were sold in relatively small amounts almost exclusively to the regular milk customers.

The milk received at the dairy came from 68 farms, situated chiefly along the Maryland & Pennsylvania Railroad, between York, Pa., and Baltimore. Most of it was from one to four hours in transit from the farms to the dairy, where it was received usually between 8 and 10 a. m. On receipt at the dairy the milk was emptied at once into a mixing tank, run thence through the pasteurizer, bottled and capped automatically, and placed at once in the refrigerator, where it was kept until delivered to customers the same afternoon and the following morning.

Up to March 19 all the milk received (with the exceptions noted later) was pasteurized by the "flash" system, being raised to a temperature of 165° F. for 2½ minutes. The cream was sold unpasteurized up to this time. From the pasteurizer the milk was passed over a coil of refrigerating pipes, the lowest part of which was some 6 feet from the floor, was received into a collecting trough, and passed thence by pipe into the bottling and capping machine.

Returned bottles were cleansed and sterilized in an automatic washing machine. The bottles, placed in the machine in wooden crates, were washed first in a strong solution of caustic soda; washed, brushed, and rinsed in clean hot water; then steamed two and one-half minutes. They emerged from the washing machine inverted in their crates, which were stacked in a corner of the dairy, with the bottles still inverted, until used. When the bottles were to be filled, each crate was "flipped" over and placed in the bottling machine, where the bottles were automatically filled and capped. For sealing the bottles, ordinary paper caps were used, fed by the capping machine from the cylindrical paper containers in which they were received. While it happened occasionally that a bottle was touched with the hands in being taken from the washer or while being placed in the filling machine, this would be exceptional. Sometimes, in all probability a bottle missed by the capping machine was capped by hand, although this was contrary to the dairy's regulations. Ordinarily, however, there was no occasion for a milk bottle to be touched after sterilization until it reached the consumer, except perhaps by the delivery man in removing the bottle from the crate.

The plant was operated with an unusually conscientious and intelligent attention to details of cleanliness. The apparent chances for infection of the milk after pasteurization were:

1. In passing over the cooling pipes and into the collecting trough, where the milk was for a few moments exposed to the air.
2. From imperfectly sterilized bottles, returned from infected households.
3. By an attendant handling or capping an occasional bottle.
4. From the hands of the delivery man touching the mouth of a bottle in removing it from the crate.
5. Cream sold unpasteurized in smaller bottles, capped by a hand machine, was somewhat more exposed to infection in the dairy.

Infection of the milk from returned bottles, improperly sterilized, seemed highly improbable, for while the system of bottle sterilization was not perfect, it was very good, the temperature and length of exposure being sufficient in all probability to destroy nonspore-bearing pathogenic bacteria. Bacteriological examination of sterilized bottles, made for the proprietor by a local bacteriologist, showed generally very few bacteria present.

Infection introduced into an occasional bottle of milk either from an infected and improperly sterilized bottle, or by the hands of an infected attendant, could hardly have been disseminated throughout the supply. While it might have accounted for scattered cases, it could hardly have caused a general outbreak among the consumers of the milk.

Infection introduced by a driver would necessarily have been confined to the route of that driver, and it is not likely that a large number of drivers should have been infected at once.

The cases and deaths were pretty generally distributed over all of the 16 delivery routes, so far as could be ascertained. Data on this point were available in 363 cases, including 17 fatalities. The distribution of these cases on the various routes is as follows:

Route No.	Families affected.	Total cases.	Fatal cases.
1	8	10	2
2	7	19	1
3	4	30	1
4	6	8	2
5	9	20	1
6	8	23	1
7	27	52	2
8	14	32	2
9	22	52	
10	12	24	1
11	12	26	1
12	5	9	
13	3	8	1
14	10	20	
15	1	1	1
16	16	29	1
Total	164	363	17

While the cases were not uniformly distributed over all the routes, it will be noted that no route altogether escaped, and that there is no significant grouping of cases on any one route. Especially in regard to the fatalities, the records of which are doubtless more complete than the morbidity reports, it will be noted that they are quite uniformly distributed along the various delivery routes.

Notwithstanding that it would appear difficult to understand how the milk could have become infected subsequent to pasteurization, the possibility must be carefully considered, since there was a distinct outbreak of sore throat among the employees of the dairy, the details of which are as follows:

On February 21 one of the employees of the dairy, the manager who supervised the operation of the plant, was taken sick with a comparatively mild attack of tonsilitis which confined him to his home on the 22nd, 23rd, and 24th. In the late afternoon of February 22 another employee, the driver of one of the delivery wagons, who had been feeling badly for a few days, was taken suddenly ill with what appeared to be an acute attack of appendicitis. He was at once removed to a hospital, where it developed later that he was suffering from a rather severe case of tonsilitis with acute abdominal pain, a complication noted quite frequently in this epidemic. On February 28 another employee, a route boss, was taken sick with sore throat of about 10 days' duration, with enlarged cervical glands. One of the drivers was taken sick March 3 and another March 6, both with rather severe tonsillitis.

The personnel of the dairy during this time was:

Proprietors	2
Manager of plant	1
Bottling room employees	5
Engineer	1
Route bosses	3
Deliverymen	16
Stablemen and haulers	4
Laborer	1
Ice cream department	3
	36
Office force	5
Total	41

It was said that practically all of these drank milk rather freely.

Cases of similar illness, sore throat with enlarged glands, considerable prostration, and slow convalescence also occurred during this time in the family of the proprietors, who had his residence in the same building above the dairy, viz, February 23, a servant girl; February 29, the wife of one of the proprietors; March 6 and 8, respectively, two young children.

With one exception, all of those who were sick, both employees and members of the proprietors' family, drank milk quite freely, as did all the employees.

These cases, occurring at the height of the epidemic, can hardly be considered as the sources of the outbreak among the customers of this dairy, since the epidemic among the latter had started at least a week earlier. It is more likely that the infections in the dairy employees were contracted from the same cause as the outbreak among the customers, namely, the use of infected milk.

As to the probability of the milk having become infected before pasteurization, it is evident that pathogenic germs introduced into the milk at any time prior to its passage out of the mixing tank—that is, at one of the farms or on receipt at the dairy—would have been distributed quite uniformly through the whole supply in the process of mixing.

It was learned from the proprietor that for a period of five to seven days, beginning January 29, he had distributed unpasteurized milk to his customers, while some changes were being made in the equipment of his plant, namely, the installation of a new bottling machine and renewing a part of the cement floor of the main room. It was thought that owing to the unusually cold weather at that time the danger from discontinuing pasteurization for a few days would be minimized. The exact date when pasteurization was resumed was not recorded, but was satisfactorily determined to have been not later than February 5. This date corresponds approximately to the beginning of the definite outbreak, although, as is shown in chart No. 4, there had been a highly suggestive number of infections among customers of this dairy even prior to January 29.

Since the incubation period of this infection is not accurately determined it is difficult to estimate the probability of infection contracted at this time being competent to account for an epidemic reaching its maximum development from 10 to 30 days later, and continuing to attack previously uninfected families for at least six weeks after pasteurization had been resumed. (See chart No. 5.) From analogy to better-known streptococcus infections, and from several isolated instances, where persons not using this milk were attacked within a very few days after exposure to other cases, it may be justifiably inferred that the incubation period is short, and that infection conveyed through unpasteurized milk during the period from January 29 to February 5 can hardly account for the greater part of the epidemic.

Up to about March 20 the full cream received at the dairy, about 20 gallons daily, was sold unpasteurized. In order to ascertain whether this unpasteurized product was the source of infection the proprietor was requested to specify, on his list of customers, the families to whom full cream was sold. It was found that not over one-third of the cases among his patrons were in families using this unpasteurized cream, which can not therefore be considered the sole or even the chief source of infection.

The cream used for making ice cream was said to have been pasteurized.

The next question of prime importance remaining to be considered is whether the infectious agent, if introduced into the milk before pasteurization, would necessarily have been destroyed by the process employed.

According to the statements of at least two bacteriologists who had worked with cultures of the streptococcus isolated from cases of sore throat during the outbreak, this organism, supposed to have been the specific cause of the epidemic, was uniformly killed by exposure to a temperature of 165° F. for 2½ minutes—in fact, by a considerably lower temperature. It does not necessarily follow, however, that all of such organisms present in raw milk would have been destroyed in the process of pasteurization as actually applied. It is possible that as found in milk the organisms may have been more heat resistant than after cultivation on laboratory media; or that an unusually resistant minority may have survived a temperature destructive to the majority. Also, it may well be questioned whether, in the process employed, the exposure was absolutely uniform and always sufficient to destroy organisms protected by particles of solid material.

The tables following show the results of bacteriological examinations of samples of milk from this dairy, both before and after pasteurization, by the Baltimore health department.

TABLE No. 13.—*Showing results of bacteriological examinations of milk from dairy No. 1 by the Baltimore city health department.*

Month.	Before pasteurization.		After pasteurization.		
	Number of bacteria per cubic centimeter.	Colon bacillus in 0.001 cubic centimeter.	Number of bacteria per cubic centimeter.	Colon bacillus present in—	
				1 cubic centimeter.	0.1 cubic centimeter.
1911.					
January	....	....	....	....	....
February	3,000,000	+	360,000	+	+
March	....	....	....	....	....
April	140,000	0	35,000	0	0
Do	600,000	+	15,000	0	0
Do	400,000	0	15,000	0	0
May	100,000	+	1,500	0	0
Do	1,800,000	+	30,000	+	+
June	2,100,000	+	24,000	+	+
Do	6,000,000	+	36,000	+	0
July	3,600,000	+	5,500	+	0
Do	4,800,000	+	4,800	+	0
Do	10,200,000	+	21,000	0	0
August	18,000,000	+	36,000	+	0
Do	7,200,000	+	3,000	+	0
Do	12,000,000	+	12,000	+	+
September	7,200,000	+	9,000	+	0
Do	350,000	0	120,000	+	0
October	300,000	+	90,000	+	+
Do	600,000	+	20,000	0	0
November	3,000,000	+	6,000	0	0
Do	600,000	0	6,000	0	0
December	3,300,000	+	45,000	+	0
1912.					
January	1,650,000	0	15,000	+	....
Do	300,000	0	36,000	0	0
Do	500,000	0	57,000	0	0
February	140,000	0	36,000	+	0
Do	1,200,000	....	150,000	+	+
March	130,000	0	60,000	+	+
Do	230,000	0	90,000	+	0
Do	9,000,000	0	6,000	0	0
Do	160,000	0	42,000	....	0
Do	2,700,000	0	39,000	....	0
Do	180,000	+	2,300	0	0

An analysis of these results shows that in 34 examinations, made in a period of one year and three months, 50 per cent of the samples of raw milk were found to have more than 1,000,000 bacteria per cubic centimeter. According to the gradings recommended in the Report of the Commission on Milk Standards appointed by the New York Milk Committee (Public Health Reports, Vol. XXVII, No. 19, May 10, 1912) this would be classed as "milk not suitable for drinking purposes," not coming up to the bacterial standard recommended for raw milk intended for pasteurization, namely, not over 1,000,000 bacteria per cubic centimeter.

Seven of the 34 corresponding samples of pasteurized milk fail to meet the bacterial standard recommended by this commission for pasteurized milk, namely, a bacterial content of less than 50,000 per cubic centimeter. Eighteen (53 per cent) of the samples showed colon bacilli in 1 cubic centimeter, in this respect also falling below the standard recommended in the report referred to.

The milk distributed from this dairy, while very much above the average of most city supplies in quality, could not, according to the standards mentioned, be considered of satisfactory and altogether safe quality. The frequent presence of colon bacilli and the more than occasional high bacterial content of the pasturized milk would indicate that the process employed was inadequate to render the milk at all times above suspicion.

The "flash" pasteurizer used in the dairy was ordinarily regulated by an automatic thermoregulator, with a thermographic attachment furnishing a permanent record of the temperature maintained and the time consumed in running the milk through each day. Unfortunately, for some three months prior to this outbreak the automatic thermoregulator had been out of repair, the temperature of the pasteurizer had to be regulated by hand, and no record was kept of it. It is probable, however, that during this time sufficient care was exercised to keep the temperature almost as well regulated as it would have been by the automatic device.

On March 19, following the advice of the sanitary expert whom he had consulted, the proprietor of the dairy put in apparatus enabling him to hold all his milk at 145° F. for 30 minutes. A short while prior to this he had begun pasteurizing all his cream, which had previously been sold unpasteurized.

Referring to chart No. 5, it will be noted that the last case in a previously uninfected family among the patrons of this dairy occurred March 24, a few days after the system of pasteurization had been changed. Cases after this date were confined to previously infected families among the patrons of this dairy and to families not supplied with this milk. Since the epidemic on the milk route of dairy No. 1 had already declined greatly before March 24, its cessation, following the adoption of a more thorough system of pasteurization, can not be unreservedly ascribed to this cause, although the inference that such was the case is, to say the least, very strongly suggested.

To summarize the evidence as to the source of infection of the milk supply, it is believed that the milk was infected prior to pasteurization, probably from some source outside the dairy, because:

1. The methods used in handling the milk after pasteurization and the care exercised in cleansing and sterilizing vessels were such as to preclude the probability, though not the possibility, of infection subsequent to pasteurization.

2. No source of infection sufficient to account for the epidemic could be found in the dairy. Although several cases of septic sore throat occurred among employees of the dairy, they occurred distinctly later than the beginning of the outbreak and, with one exception, in persons who did not handle the general supply. Finally, there was no apparent way in which infection, introduced into the milk after pasteurization, could have become generally disseminated through the supply in such manner as to cause so widespread an epidemic; whereas infection introduced into the milk prior to pasteurization would have been uniformly distributed in the process of mixing.

3. The infection was then, apparently, introduced into the milk supply before pasteurization. According to the evidence presented, neither the unpasteurized milk distributed from January 29 to February 5, nor the unpasteurized cream distributed throughout the epidemic, can be held accountable for the whole outbreak, which must therefore be considered as most probably due to infection con-

veyed in the pasteurized milk having survived an inadequately applied process.

This seems the more probable, since the results of bacteriological examinations indicate that the bacterial destruction effected by the process of pasteurization was not uniform and not at all times sufficient to bring the pasteurized product up to the standard recommended in the report of the medical milk commission, and also because the outbreak ceased rather abruptly after the "flash" system of pasteurization had been abandoned and the more reliable "holding" system adopted.

4. As to the ultimate source of infection of this milk, whether from infected persons (either sick or "carriers") or from cows, until more extensive researches can be made on the subject this will have to remain a matter of speculation.

Infection from human sources is suggested by several facts. Cases apparently identical with those constituting the epidemic were reported as occurring rather sporadically in Baltimore for at least a month prior to the epidemic outbreak, and mostly, at that time. without apparent relation to the milk of any dairy. This would give the impression that the disease was present in Baltimore prior to the epidemic, but not sufficiently prevalent to attract much attention, and probably spreading by contact. If this were so it would account for the presence of infected persons, either sick or "carriers," on some of the farms in the vicinity of Baltimore.

On the other hand, there are certain considerations which make it seem improbable that the infection was from a human source. The weather during the outbreak was generally very cold, so that there was little chance for multiplication of bacteria in the milk, especially of bacteria distinctly parasitic to man, requiring generally a comparatively high temperature for their multiplication. It seems hardly probable that an infected person of reasonably cleanly habits handling the milk on one of the tributary farms could have introduced into it a number of organisms sufficient, when distributed throughout the whole supply and decreased by pasteurization, to have caused such a massive infection. Then, too, from the prolonged course of the epidemic among the consumers of this milk, it would appear to have been pretty constantly infected for a period of three to six weeks; and such continuous infection would hardly be expected from a human source.

Supposing the infection to have originated from one or more cows with udder infection, it is very evident that the number of bacteria likely to be discharged into the milk would in all probability be many times more than the number that could probably be introduced accidentally from a human case. Also, if the infection came from cows with diseased udders it is readily understood that it would be more probably a constant, long-continued infection.

SUMMARY.

The data presented in the foregoing pages, while incomplete in many respects, are believed to have established certain facts and to warrant some conclusions, which may be briefly summarized here.

There occurred in Baltimore and its immediate vicinity, chiefly during February and March, 1912, an explosive outbreak of what may be called "septic sore throat," apparently a streptococcus infection. The extent of the epidemic can only be surmised. It may be estimated that certainly not less than 1,000 and perhaps as many as 3,000 cases occurred in this outbreak, causing 30 or more deaths.

Whether the epidemic was due to an infection newly introduced into that vicinity from without or to a sudden increase in the prevalence of an already present endemic infection can be only surmised. In either case, it is quite clear that the infection was disseminated chiefly by the milk of one of the larger dairies in Baltimore, and it is highly probable that the epidemic was very considerably augmented and prolonged by contact infection.

As to where the milk supply in question became infected, it is believed that it must have been prior to its receipt at the pasteurizing and distributing plant in the city, and that the infective agent in all probability survived the inadequate "flash" process of pasteurization employed at that time.

Only surmises can be made as to the ultimate source of the infective agent. Two possibilities are to be considered: Either that the pathogenic germs were introduced into the milk by some infected person who had to handle the milk, or that they were derived from the udder of some of the cows which produced the milk.

The latter is believed to be the more probable hypothesis, although no evidence could be obtained of an epidemic among the cows on any of the supply farms, and a veterinary examination of all the herds from March to April failed to discover any cows with mastitis.

A special interest attaches to this epidemic because two similar outbreaks have been reported from large American cities within a year, and several smaller epidemics have been mentioned as having occurred within the same period. [1] [2]

An epidemic clinically similar, and due apparently to the same infective agent, occurred in Boston, Mass., and vicinity in May, 1911. This epidemic of at least 1,000 cases, of which about 50 resulted fatally, was very clearly shown by Winslow [3] to have been due to infection disseminated in the unpasteurized milk distributed by one of the most excellently conducted dairies in the State.

The second of the epidemics referred to occurred in Chicago, Ill., in the winter of 1911–12. The available reports of this outbreak are fragmentary; but it is said to have been quite extensive and believed to have been like the Boston epidemic, traceable to infection of the milk of a single large dairy.

This rapid succession, in three widely separated cities, of severe epidemics, of a new or previously rare and very serious infectious disease should direct the attention of the public health authorities to a serious consideration of its cause and prevention.

To determine the specific cause of such epidemics, it is of the utmost importance that careful bacteriological studies should be made of any similar outbreaks which may occur in the future. The studies should not be confined to the clinically recognized cases of the disease, but extended to well persons who may at such times become "carriers," and to the milk, which seems to be the chief vehicle of infection. In the meantime it is of no less importance that studies in the differentiation of varieties of streptococci be continued.

---

[1] Davis, D. J.; and Rosenow, E. C.: An epidemic of sore throat due to a peculiar streptococcus. Journ. Am. Med. Assn., Mar. 16, 1912, vol. 58, p. 773.

[2] Miller, J. L.; and Capp, J. A.: Epidemic of sore throat due to milk. Journ. Am. Med. Assn., Apr. 13, 1912, vol. 58, p. 1111.

[3] Winslow, C.-E. A.: Journ. of Infectious Diseases, vol. 10, no. 1, January, 1912, pp. 73–112.

For the prevention of similar epidemics attention will have to be directed first of all toward safeguarding our milk supplies in such manner as to make it impossible for infection to be disseminated through them. Winslow has used the epidemic in Boston to illustrate that even the most rigid, conscientious, and intelligent sanitary supervision is inadequate to protect raw milk from the danger of becoming contaminated with disease-producing germs and giving rise to serious epidemics. He has made it the text for one of the best arguments ever presented in favor of the proper pasteurization of milk supplies.

The Baltimore epidemic illustrates with equal force the truth of Winslow's supplementary statement, that pasteurization as commercially practiced is often merely a delusion. This epidemic can be satisfactorily accounted for only by the failure of the "flash" system of pasteurization to pasteurize. It is believed that with the exception of the few days early in February, when the pasteurizer was out of operation, the pasteurization process used in the Baltimore dairy was conscientiously applied, and that reasonable precaution was used in the subsequent handling of the milk. The trouble lay apparently in the inadequacy of the process used. It is confirmation of the already widespread belief that the so-called "flash" system of pasteurization is inefficient, as recently demonstrated by Rosenau and Schorer,[1] and that milk to be rendered safe must be held at a temperature of not less than 145° C. for at least 20 minutes, as recommended by the committee on milk standards appointed by the New York Medical Milk Commission.

The public is realizing more and more the danger from milk-borne infections and, more slowly, the practical impossibility of producing in large quantity the ideally "pure" raw milk. They are commencing to demand the protection of pasteurization, and it is no more than their just due to have a guarantee that this supposed safeguard is really effective.

It is time that regulations should be made and enforced requiring all milk sold as "pasteurized" to be heated to a sufficiently high temperature for a sufficient time to insure the destruction of pathogenic germs; and equally important to require that it shall be handled in such a way as not to expose it to any chance of becoming infected after it has been pasteurized.

Students of preventive medicine are rapidly adopting the belief that the ultimate solution of the problem of preventing the spread of infectious diseases by milk lies in a requirement that all the milk sold in cities shall be pasteurized under official supervision.

This can be accomplished only by demonstrating the greater safety of pasteurized milk—a demonstration which can be made only by legally defining and properly regulating the process. The writer has had occasion within the last year to study two large milk-borne epidemics, one of typhoid fever in Little Rock, Ark., and the one here reported, both due to infection conveyed in so-called "pasteurized" milk. Such occurrences give serious setbacks to the propaganda for pasteurization. They can be prevented only by enforcing a more rigid standard and prohibiting the use of the label "pasteurized" for milk that does not come up to the standard.

---

[1] Rosenau, M. J., and Schorer, E. H.: Tests of the efficiency of pasteurization of milk under practical conditions. Journ. Med. Research, April, 1912, vol. 26, pp. 127-158.

As an additional measure for the prevention of such epidemics, septic sore throat should be placed upon the list of reportable diseases. Had prompt reports of the cases occurring in Baltimore been made to the health department, it would have been easy to discover the source of the epidemic in time to prevent perhaps the greater part of it. Where this disease is not reportable, special attention should be paid to negative diphtheria cultures, and any considerable increase in the number of cultures showing streptococcus infections should be investigated.

Since the infection appears to be quite readily transmissible from person to person by contact, isolation of patients should be at least recommended if not required.

BACTERIOLOGICAL STUDY OF THE OUTBREAK.[1]

By Wm. Royal Stokes, M. D., and F. W. Hachtel, M. D., Baltimore, Md.

Before stating the results obtained from the bacteriological study of the epidemic of septic sore throat which has been described above by Dr. Frost, a short historical review of the gradual development of our knowledge concerning this subject may be of some interest.

HISTORICAL REVIEW.

We are informed by Freeman[2] that in 1732 the authorities of Braunschweig-Luneburgische passed an edict compelling the milk to be poured on the ground and buried, owing to an epidemic among the cows whose milk was of a yellowish color or contained yellowish-red streaks. It is not at all improbable that the dangerous character of milk from cows suffering from garget was recognized at that time.

The infectious nature of acute purulent mastitis was not emphasized, however, until 1890, when Krueger[3] attributed this condition to the *staphylococcus aureus* which he found in the milk.

Guillebeau[4] later confirmed this opinion by finding virulent staphylococci and streptococci in 72 cases of mammitis.

The relation between purulent mammitis produced by the *streptococcus pyogenes* and epidemic sore throat seems to have first been observed by Pierce[5] who described an extensive outbreak in Guilford in 1903. In addition to the inflammation of the throat, Pierce mentions marked glandular enlargement, fever, and erysipelas, and states that a few cases were fatal. Four cows on the incriminated dairy farm were affected with mammitis, and a streptococcus was isolated which was virulent for mice.

A later epidemic of septic sore throat which occurred in Colchester consisting of about 600 cases is mentioned by Savage.[6] In addition to red and swollen throats some of the cases showed pseudomembranes, and the submaxillary glands were generally enlarged. The origin of the epidemic was traced to a case of mammitis on a farm supplying a certain milkman, and abundant streptococci were isolated from the quarter of the udder affected with mammitis.

---

[1] From the laboratory of the state and city boards of health, Baltimore, Md.

[2] Proc. of the 3d An. Con. of Med. Milk Com., June 7, 1909, p. 95.

[3] Central. f. Bakt., 1890, VII, p. 590.

[4] Landw. Jahrb. Schweiz., 1892, p. 27.

[5] Brit. Med. Jour. II, 1903, p. 1492.

[6] Milk and the Public Health, 1912, p. 99.

This author[1] also mentions the Christiania epidemic, which consisted of 548 reported cases. The usual symptoms of septic sore throat were noted, and there were numerous cases of pyemia and a number of fatal cases. The source of the epidemic was traced to a case of bovine mammitis, and numerous long-chained virulent streptococci were isolated from the diseased udder.

Other epidemics in which streptococci were isolated from the milk obtained from diseased udders are described by Trask[2] as occurring at Woking and Glasgow, and the relation between *streptococcus* mammitis and septic sore throat has been recognized for some time, owing to these various investigations.

It is evident that no attempt could be made in these epidemics to classify the streptococcus according to the most recent cultural and morphological tests, and such tests have only been applied in the outbreaks occurring in the past two years.

The most complete study of the various cultural and morphological characteristics of the two distinct varieties of the streptococcus observed in connection with an epidemic of septic sore throat was made from the human cases and from the milk of cows affected with garget in specimens obtained in the Chicago epidemic of December, 1911, and January, 1912. It was estimated by Capps and Miller[3] that about 10,000 persons were affected in this outbreak, and the source of the epidemic was clearly traced by these observers to a special dairy. Davis[4] has shown that in the majority of cases the organism isolated from the inflamed throats corresponded with the ordinary *streptococcus pyogenes*, but in many of the internal lesions such as peritonitis, arthritis, suppuration of the cervical glands, broncho-pneumonia, and endocarditis, that an organism differing from the *streptococcus pyogenes* was present.

This latter organism usually occurs in short chains or pairs when obtained from the exudates or from smears from the throat. They are positive to Gram's stain and surrounded by a capsule which is smaller than that surrounding the pneumococcus, and which does not indent between the pairs as in the case of the other organism. The colonies are larger and more moist than those of the ordinary *streptococcus pyogenes*, and the zone of hemolysis is usually narrower and the outer margin is at times indistinct. Although the surface colonies are abundant and moist, yet they have not the special mucoid character of the *streptococcus mucosus*. In bouillon a uniform cloudiness is present and milk is always acidulated and at times coagulated. These organisms are partially soluble in bile and autolyze in sodium chloride solution. This organism ferments dextrose and lactose, but does not ferment raffinose, mannite, or inulin.

This streptococcus when injected into guinea pigs, mice, and rabbits usually produces a fatal septicemia within 24 hours, and when injected intraperitoneally a general serositis follows. When injected into rabbits the organism will also produce arthritis and occasionally a vegetative endocarditis.

In an earlier article Davis[5] also states that four cultures received from Dr. Fabian, of Boston, which were obtained from the epidemic described by Winslow and mentioned above by Frost, appeared to be identical with the special streptococcus isolated from the Chicago epidemic. The bacteriology of the epidemic sore throat which occurred in Baltimore has been studied by Luetscher,[1] who obtained pure cultures from five typical cases of this disease. This organism apparently possessed most of the cultural characteristics of that described by Davis as the *streptococcus epidemicus*, but one or two of these organisms fermented raffinose. This writer also mentions the fact of these organisms growing in culture media in long chains and that they precipitated serum-glucose-agar. All of these cultures were obtained from the circulation or from various lesions of the serous cavities or purulent lymph glands, and none of them were obtained from the throat of the patient.

---

[1] Milk and the Public Health, 1912, p. 100.

[2] Bul. 56, Hyg. Lab. United States Public Health Service, 1909, p. 116.

[3] Capps and Miller. Jour. Amer. Med. Assn., Vol. LVIII, No. 24, June 15, 1912, p. 1848.

[4] Davis. Jour. Amer. Med. Assn., Vol. LVIII, No. 24, June 15, 1912, p. 1852.

[5] Davis, Jour. Amer. Med. Assn., vol. lviii, No. 17, Apr. 27, 1912, p. 1283.

From what has gone before it can be seen that independent observers have isolated an organism from a number of cases of septic sore throat which differs in several respects from the *Streptococcus pyogenes*. These observations were made in three different cities, and although the organisms differ in minor respects, yet they can all be considered as types of the same organism. Most of these bacteria were isolated from internal lesions of various kinds. The sources of the streptococci obtained from the Boston epidemic are not mentioned by Davis. Taking for granted that none of these were actually isolated from the throat, it would seem that the evidence supported the contention of Davis that the ordinary *Streptococcus pyogenes* found in sore throats may assume the type of the *Streptococcus epidemicus* after passage through the tissues of human beings or animals. His experiments seem to lead to such a conclusion, but in the text which follows it will be seen that we have been able to obtain cultures of the epidemicus type from the inflamed throat itself.

There can be little doubt, therefore, that this organism is capable of producing an inflammation of the throat itself, whence it can enter the internal tissues and produce the various lesions characteristic of epidemic sore throat.

LABORATORY INVESTIGATION.

As a result of the striking outbreak of septic sore throat in Baltimore, a laboratory investigation was made by the health department to determine the relation of the milk supply to the epidemic. The cases being so disproportionate among the customers of dairy No. 1, the examination of this supply was immediately begun. This study is divisible into that of the pasteurized product, that of the raw milk, and that of cultures from the throats of the employees of the dairy. In addition to this, the herds of those shippers whose milk fell under suspicion were examined for mastitis, and an inquiry was also made as to the occurrence of sore throat on the dairy farms supplying this pasteurizing plant.

PASTEURIZED MILK.

The milk was collected at the plant and centrifugalized in quantities of 50 cubic centimeters for 30 minutes; from the sediment stroke cultures were made with a sterile glass rod over the surface of a series of five neutral dextrose-agar plates. At the end of 24 hours suspicious colonies were picked and inoculated on slant dextrose-agar, and from these subcultures were made in milk, gelatin, bouillon, peptone solution, inulin serum-water and on the surface of blood-agar plates and Libman's dextrose serum agar. The organisms isolated were Gram-positive diplococci growing as small, discrete, translucent colonies on agar. They acidulated and coagulated litmus milk, did not liquefy gelatin, produced no cloudiness in bouillon or peptone, failed to form indol and acidified and coagulated inulin-serum-water. They caused no hemolysis on rabbit blood-agar, but grew as greenish, somewhat blistered, small colonies. On Libman's dextrose-serum-agar these diplococci failed to precipitate the protein at the end of 10 days' incubation. They were also soluble in rabbit's bile.

---

[1] Ibid, vol. lix, No. 11, Sept. 14, 1912, p. 869.

Portions of a pure culture of a 24-hour agar growth subcutaneously inoculated into mice at the root of the tail caused a fatal septicemia, typical lancet-shaped cocci being recovered from the liver, spleen, and heart blood.

When stained by Welch's method smears from the tissues and from milk cultures showed very distinct capsules. From the aforementioned characteristics these organisms were classified as pneumococci.

Besides this, each of 7 mice was subcutaneously inoculated with the sediment from 50 cubic centimeters of pasteurized milk. These were kept under observation for two weeks, at the end of which time none had died.

RAW MILK COLLECTED AT THE LOCAL RAILROAD STATIONS.

On March 20 the department started an intensive examination of the milk shipped to dairy No. 1, collecting specimens from the product as it arrived at the local depots. In all 214 different samples were brought to the laboratory from this source. As the first step in this investigation each of these specimens was examined by the Slack method for pus and streptococci. As each sample was from a can representing on the average the mixed milk of 5 cows, any showing 10 pus cells or more per field was classed as suspicious; also every one showing excessive numbers of streptococci was subjected to further investigation. Of the 214 milks 23 were considered suspicious as measured by the above criteria.

The sediment from 50 cubic centimeters of each of the 23 samples was then suspended in 2 cubic centimeters of sterile normal salt solution and half this quantity was injected beneath the skin of a mouse at the root of the tail. As the result of this 14 mice succumbed. Autopsies were made in every case; smears from the liver, spleen and heart blood were stained and Gram-positive, lanceolate, encapsulated diplococci were demonstrated.

Cultures were also made from the various organs, at first on the surface of dextrose-agar plates, later on blood agar. From six of these animals we obtained pure cultures of a microörganism resembling that isolated from the pasteurized milk and which we believe to be the *diplococcus pneumoniæ*. It should be stated that these micrococci were studied on all the culture media previously mentioned, and five of them found to be bile soluble when subjected to this test. From one of these samples we also isolated a typical *streptococcus pyogenes*.

In addition to this we recovered from this same specimen a coccus of the following character: It was a Gram-positive diplococcus or short-chain streptococcus with a distinct capsule or halo, though this was not so marked as that surrounding the pneumococcus. Within the chains the organism occurred in pairs, but the capsule showed either no indentation or but a very slight one between these intracapsular groups. The growth on slant agar was translucent and moist, and after several generations became less profuse; in bouillon it produced marked turbidity, it acidulated and coagulated litmus milk, caused no change in inulin-serum-water, did not liquefy gelatin and caused Libman's dextrose-serum-agar to become very cloudy. On blood-agar plates the colonies were moist, somewhat larger than those of *streptococcus pyogenes*, had a tendency toward spreading, and were surrounded by clear zones of hemolysis with a greenish tinge by transmitted light.

When first isolated this streptococcus fermented dextrose, maltose, lactose, saccharose, and dextrin bouillon, but failed to ferment inulin, raffinose, and mannite bouillon; however, after several months of laboratory existence the organism now ferments raffinose broth. It was not very soluble in bile. It therefore corresponds in the essential cultural characteristics and in its morphology to the *streptococcus epidemicus.*

When inoculated subcutaneously into a mouse the animal died in 24 hours. At autopsy it showed purulent peritonitis, and the streptococcus was recovered from the peritoneum, liver, spleen, and heart blood.

MILK COLLECTED AT DAIRY FARMS.

Following up the above results, inspectors were immediately sent to the farms of all shippers whose milk showed pus or streptococci in excess of the aforementioned numbers; in all, seven dairy farms were thus visited.

At all of these milk from each cow was collected in a separate container and brought to the laboratory. Here these specimens—58 altogether—were centrifuged and examined for pus cells and streptococci. This showed the milk of one or more cows on each of the dairy farms except two to contain more than 25 pus cells to the immersion field; while in one case, and that a sample from the shipper whose milk contained the microörganisms of the *Streptococcus epidemicus* type, the pus count was 100 (approximately). This count was accompanied by 50,000 diplococci or short-chain streptococci per cubic centimeter, as determined by the Slack method. Some of these had a distinct lanceolate shape and appeared to be surrounded by a halo. In all there were 6 samples showing pus cells in excess of 25 to the field.

All of these six milks were centrifugalized in quantities of 50 cubic centimeters, and in each instance a half of the sediment suspended in salt solution was inoculated subcutaneously into a white mouse. Altogether, however, we inoculated mice with the sediment from 15 different samples, all of them, save 1, containing 10 cells or more per field. This one exception was the milk from a cow whose udder had been scratched by a dog and was found to be indurated.

Six animals survived; 2 of these were injected with sediments containing 30 and 40 pus cells and 0 and 50,000 streptococci, respectively. None of the other 4 showed more than 50,000 streptococci per cubic centimeter.

From 5 of the 9 mice that died pneumococci were isolated. These bacteria were typical morphologically and culturally. One of these mice had been inoculated with a milk containing 40 and the other with a specimen showing 50 pus cells to the immersion field. A third had been inoculated with one with 100,000 diplococci and but 10 cells, this sample having come from a cow on the dairy farm under suspicion. In the tissues of 1 of the 4 remaining animals a microorganism was demonstrated which morphologically resembled the pneumococcus; however, this diplococcus was not obtained in pure culture. Stained smears prepared from the tissues of the other 3 mice were negative. Cultures were made, but these were so overgrown by colon bacilli that no bacteria of the pneumococcus or streptococcus type were recovered. One of these animals had been injected with the sediment having 100 pus cells to the field; as previously stated, this sample was from a cow owned by the dairyman from whose milk the *Streptococcus epidemicus* had been isolated. The pus cells in this case occurred in large groups obscuring the field; this is well shown in the accompanying photomicrograph. This count was associated with 50,000 diplococci and short-chain streptococci per cubic centimeter; however, owing to the enormous masses of cells the enumeration of bacteria must have been very inaccurate.

CULTURES FROM THROATS OF EMPLOYEES OF DAIRY NO. I.

Concurrently with the investigation of the milk a bacterial examination of the throats of the family and employees of the owner of the pasteurizing plant was undertaken with the purpose of determining the presence of carriers. This was rendered doubly necessary by the fact that several cases of sore throat had occurred in the family and among the employees.

Altogether 46 cultures were made on blood serum and these were smeared on slides and stained by Gram's method. By this method it was possible to eliminate 12 cultures. The rest were plated out on the surface of litmus-inulin-agar. This medium was used because we found it impossible at this time to get enough blood agar for the purpose. Suspicious colonies were fished and subjected to careful cultural study.

Thirty-one of the organisms thus obtained—each from a different person—showed the following characteristics: They were Gram-positive diplococci that under suitable conditions showed capsules; they grew as discrete, translucent, dropletlike colonies on slant agar; produced no cloudiness in broth or peptone solution; did not liquefy gelatin; either acidified or acidified and coagulated litmus milk; caused no turbidity of Libman's dextrose-serum-agar; acidulated and coagulated inulin-serum-water; and later, when grown on blood agar, formed small, green, blistered colonies. Several picked at random were found to be bile soluble. These 31 strains were inoculated into mice in large doses and only three of the animals succumbed; from these the same diplococci were obtained. From the characteristics detailed these organisms were classified as pneumococci.

Two other cultures, each from a separate source, will bear description. Both of these were from drivers, neither of whom had had sore throat. One of these two cultures resembled in most of its cultural characteristics the organisms isolated from milk and from cases of septic sore throat; it differed from these in that it failed to ferment raffinose broth and to coagulate milk. It, however, was not pathogenic for white mice when subcutaneously inoculated in large quantities.

The streptococcus isolated from the throat of the other driver, however, was not typical and gave the following cultural characteristics: It produced a slight cloudiness when grown on Libman's dextrose-serum-agar; a very narrow zone of hemolysis of a greenish tinge; it did not ferment inulin-serum-water; produced turbidity in broth in 72 hours; acidulated and coagulated milk, and did not liquefy gelatin. The colonies on blood-agar were small and green.

CULTURES FROM CASES OF SEPTIC SORE THROAT.

From the few cultures from suspected cases of septic sore throat that were sent to the health department laboratory during the outbreak we isolated the *Streptococcus epidemicus* in two instances. These were obtained directly from the inflamed throat and not from any metastatic lesions. A comparison of these with three cultures that had been isolated from the peritoneum or from the lymph glands showed them to correspond with one another in their essential morphological and cultural characteristics. For these latter streptococci we are indebted to Dr. Charles Simon and to the Union Protestant Infirmary. It should be stated that, whereas both of our organisms fermented raffinose broth, one of those obtained from the lymph glands did not produce an acid reaction in this medium. Neither of the children from whom we obtained the *Streptococcus epidemicus* had drunk milk from the dairy under suspicion, and both were probably contact cases, as the disease was present in the schools which they attended.

INSPECTION OF THE DAIRY FARMS.

When, as the result of the pus counts made on the specimens collected at the railroad stations in Baltimore, the milk of any shipper was found suspicious, an inspector was immediately sent to the dairy farm. In addition to collecting milk from each cow he examined the herd for garget. As the result of this several cases of mammitis were found on different farms, but these cows were not being milked. The cow whose milk contained such enormous numbers of pus cells did not show any physical evidence of garget, nor did any other animal in this herd have mammitis. It was from the milk of this dairy farm, however, that we isolated the streptococcus peculiar to this outbreak.

At the same time a careful inquiry was made to determine whether there had been any cases of septic sore throat on any of the dairy farms. No history of the disease, however, could be obtained, though one of the shippers said that he had had several mild attacks of sore throat during the winter.

SUMMARY.

A painstaking investigation of the pasteurized milk prior to the installation of the holding device failed to show the presence of the *Streptococcus epidemicus* at this time. We did, however, recover slightly virulent pneumococci from these samples, thus demonstrating the inefficiency of the "flash" method.

The examination of the raw milk shipped to dairy No. 1 resulted in the isolation of an organism of the *Streptococcus epidemicus* type. This was recovered from the mixed milk of one shipper as it arrived at the local railroad depot. Further investigations showed the presence in this shipper's herd of one cow whose milk contained inordinate numbers of pus cells. (See fig. 1.) We were unable to obtain either pneumococci or streptococci from this milk, as the cultures were overgrown by *B. coli.*

Cultures taken from the throats of the family and employees of the owner of the pasteurizing plant demonstrated the fact that one of the drivers was a "carrier"; he, nevertheless, had not had sore throat.

The examination of the herds on suspected dairy farms disclosed the presence of several gargety cows. These had not been milked for some time previous to the investigation. The cow whose milk contained 100 pus cells to the field gave no physical evidence of mastitis, and was being milked at the time. Although a careful inquiry was made, no history of cases of septic sore throat on the farms could be elicited.

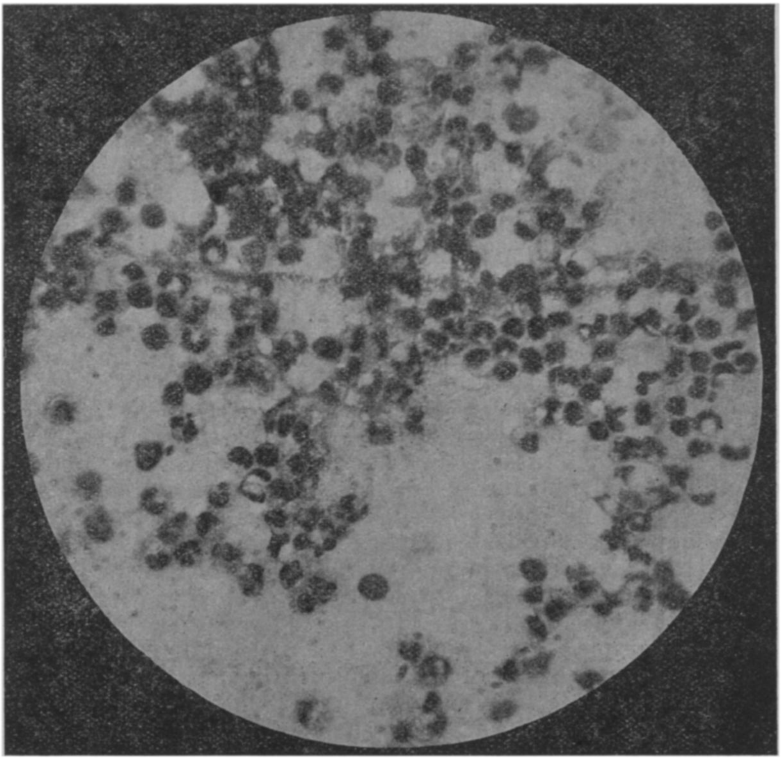

FIGURE 1.—Photo-micrograph showing large number of pus cells in the milk from a case of garget detected on one of the dairy farms.

There can be no doubt that the epidemic was very largely due to the pasteurized milk from dairy No. 1, this being subjected to 158° to 165° F. for two and a half to five minutes; and from the bacteriological study we feel reasonably sure the infection was caused by streptococci of the *epidemicus* type from cases of mastitis among the herds supplying this dairy.

We are greatly indebted to Dr. Frederick C. Blanck and his assistants for their aid in making this investigation, and desire to express our gratitude to them. We also desire to thank Mr. Clifton Howes, assistant chemist, for the photomicrograph.